Time and water efficiency in tank cleaning

THE SPRAY NOZZLE PEOPLE

EFFICIENT TANK CLEANING

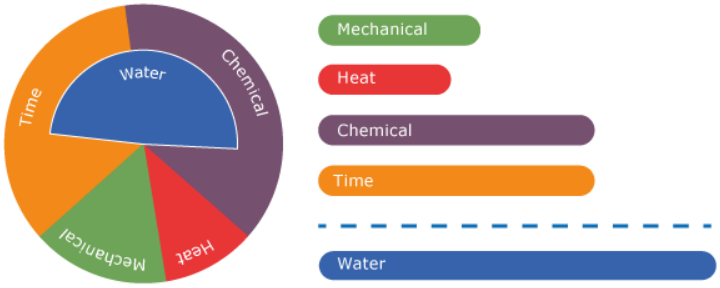
The cleaning of tanks and vessels is achieved by a mixture of 4 elements: time, mechanical action, heat and chemical action. These four elements are illustrated on Sinner Circles, which are pie charts showing proportional contribution each element makes to overall cleaning.

The mechanical action element is effectively a function how the cleaning fluid is delivered to the cleaning surface. Similar volumes of water will achieve drastically different mechanical actions depending on the nature of their delivery. The delivery of the fluid depends on the pressure it being sprayed at and, most importantly, on the type of tank cleaning head used.

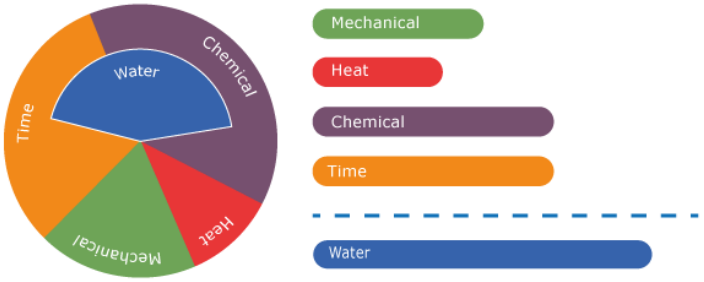
At one end of the scale we have a finely atomised spray, this will deliver almost no mechanical action other than the gentle rinsing as the water runs down the side of tank. At the other end of the scale the same volume of water delivered in the form of a high pressure jet will contribute a very high level of mechanical cleaning action.

When using static spray balls for tank cleaning the water is split into multiple small jets. This splitting of the water, whilst not the same as atomisation, none the less reduces impact hugely. Washing is achieved mostly by water cascading down the sides of the tank rather than by direct impact cleaning, the action of the water is actually more rightly considered to be part of the chemical element of the cleaning mix. In order to compensate for a very small mechanical action component of cleaning the chemical action element needs to be increased in the form of higher flow rates. Furthermore as the mechanical

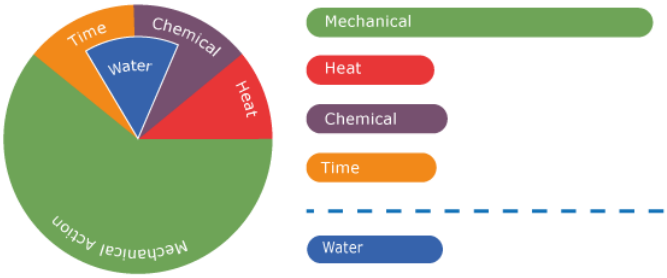
Static Spray Balls



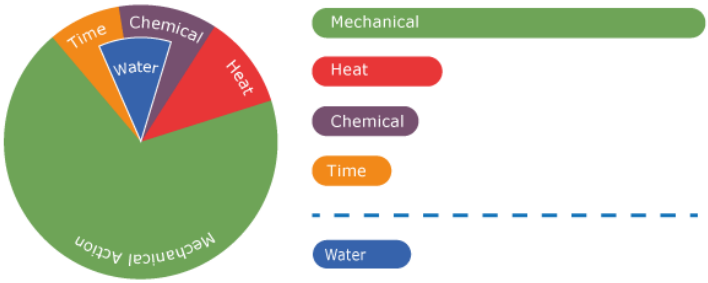
Rotary Spray Cleaners



Rotary Jet Cleaners



Fast Cycle Jet Cleaners



action component is so minimal the time element also needs to be increased considerably in order to achieve the desired results.
So with spray balls and other static tank cleaning systems we tend to see increase flow rates and increase cleaning times. This translates to a lot of water being used. In short spray balls are very water inefficient.

With impingement cleaners direct jets deliver high impact cleaning and so the mechanical action component is greatly increased. This means that other elements can be reduced. The reduction in the time component, however, is limited to the time the cleaning head takes to build up its complete cycle. Because jets are being used to clean the tank, rather than water cascading down the walls, the jets need to be brought to bear on each part of the tank in a set cycle. Anything under the minimum time and cleaning will not be complete. So, unlike spray balls, there is a hard lower limit on the amount of time rotary jet cleaners need to work for. This can mean that rotary jet cleaners are not suitable for small tanks or residues that only need quick rinse cycles from static nozzles.

Rotary spray balls represent a halfway house between static balls and impingement cleaners. They deliver more impact than static nozzles but nowhere near as much as jet cleaners. That being said they do have the advantage of not needing to conform to a minimum cleaning cycle as complete coverage is achieved within a few seconds. Obviously, given the limited mechanical action of rotary spray balls, considerable time is still required to achieve cleaning particularly for tougher residues.

New innovations

Traditionally impingement cleaners have been seen as being necessary only for larger tanks or heavy residues. For very big tanks they are the only viable option as only jet cleaners have the necessary reach. With tough residues the time it will take for low impact cleaners to break down the residue make them inefficient both in terms of water used and down time on the process vessel so, again, impingement cleaners are the only viable option.

This means that rotary jet cleaners have primarily been designed to cleaning large tanks with tough residues impingement cleaners have typically been geared to rotate quite slowly. The slow motion gives the cleaning jets enough dwell time to really act on heavily soiled tank walls. This slower motion, coupled with the hard lower limit on time due to set cleaning cycles (discussed above), means that most impingement cleaners have been inefficient (in terms of water usage) for small tanks or lighter residues. However, a new breed of fast cycle impingement cleaners is promising to change that.

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The need for speed

For smaller tanks with lighter residues a fast cycle jet cleaner (FCJC) can save considerable amounts of time and water. The principle is simple: the rotary jet cleaner gives a much higher mechanical action contribution to the cleaning mix, as the FCJC is geared to run very fast this means cleaning cycles can be reduced also. The fast gearing means some mechanical action is lost at further distances because the fast motion of the jets causes them to break up more quickly than on slower geared machines. But for smaller tanks below a 3 or 4 meters in diameter the fast moving jets maintain integrity to deliver impact cleaning. What this all means is the new FCJC's can replace spray balls and achieve some very significant water savings per cleaning cycle.

Two Factors to consider

Tank size

As tanks increase in size they require larger flow rate spray balls to rinse them. The reach of static nozzles depends very much on the amount of fluid going through them. Also the cleaning is performed by a fluid flowing down the walls of the tank a certain volume of fluid is required to achieve the necessary cascading. All this means that as tank diameter increases the flow through spray balls increase dramatically. The same is not true for impingement cleaners. Even small 3mm nozzle machines running at low pressures achieving cleaning jet length of several meters.

For sub 1 meter diameter tanks small spray balls will low flow rates will typically be sufficient. As such even the new fast cycle impingement cleaners may struggle to be beat static nozzles on efficiency. Even so for tougher residues that would require a cleaning cycle of over 20 minutes using static cleaners, the rotary jet cleaners may still be more water efficient and will certainly do the job quicker. As an example fast cycle jet cleaners running at low pressures (3 bar) can complete a cycle in about 6 minutes or under 3 minutes at higher (10 bar pressure).

As tank size increase the benefits of the faster cycle jet cleaners increased exponentially. For tanks in the 2 meter diameter range rotary jet cleaners will almost always be significantly more water efficient than static cleaners. Only very light residues that require a sub 5 minute clean with static spray balls would not be suitable for fast cycle jet cleaners (FCJC). Much above 3 meters in diameter and static spray balls will always use more water than FCJC's and with anything above 5 meters will normally be out of range for spray balls anyway.

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Residue type

Other than tank size the residue type is the biggest factor when determining the amount of cleaning power required. As noted at the beginning of this article static spray balls will break down tough residues eventually but require time to do so. Of course for tougher residues this mean that static spray balls become more and more water thirsty. When tough residues are combined with larger tank sizes the overall water consumption per cycle by static cleaners can get very large indeed.

In contrast even small nozzle impingement cleaners at low pressures can blast through tough residues. Of course higher pressures are always advisable for sticky and heavily soiled tanks. What this means is that where a static nozzle may take 20 minutes to achieve cleaning an impingement cleaner will do the job in a single cleaning cycle which can be well under 5 minutes. Additionally as the flow rates are typically lower through impingement cleaners so not only is time saved by water per minute is saved also resulting in potentially huge efficiency gains.

How big are the savings?

The short answer is "it depend on the tank size and residue" the longer, and more useful, answer is best illustrated with some examples.

Example 1

A 2 meter diameter tank with a moderate residue that needs a ½" BSP spray ball to run for 15 minutes to clean thoroughly. A typical flow rate at 2 bar pressure for such a spray ball would be 127 litres per minute meaning 1905 litres is required for cleaning. In contrast a 4x 3mm nozzle FCJC running at 8 bar pressure would consume 78 litres per minute and complete its cycle in about 3.2 minutes meaning cleaning is completed with 250 litres. So that's nearly 1/8th the water and 4.7 times as fast. So even if the FCJC had to go through 2 or even 3 cycles it would still be vastly more efficient. Given that it is running at 8 bar it is likely that a moderate residue would be cleaned with just a single cycle.

Example 2

A 4 meter diameter tank that has a light residue. This is washed down on a 10 minute cleaning cycle with a ¾" spray ball running at 2 bar. This has a flow rate of 310 l/min so cleaning requires 3100 litres. In contrast a 4mm nozzle jet cleaner running at only 3 bar pressure could go through a cycle in 5.5 minutes consuming 67 litres per minute for a total water per cycle figure of only 369 litres. This is over an 8 fold reduction in water consumption and the cleaning is completed nearly twice as fast.

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Conclusions

The new fast cycle jet cleaners offer some potentially very large water savings as well as considerable time savings. They will not be suitable for all rinse applications but for many tanks that were previously considered to be too small for impingement cleaning it might be worth running an analysis to see what efficiencies can be achieved. Of course any gains in water and time will need to be weighed against the cost of the jet cleaners, as they are more expensive than static spray balls. Furthermore there might be some increased pumping costs as they may need to run at higher pressures. But if water consumption per cycle can be reduced by a factor of 5 or more then such additional cost will quickly be recouped.